Study of GML-Based Geographical Data Visualization Strategy

ZHANG LIN 1, CHEN SHI-BIN 2
1 College of Information Technology, ZheJiang University of Finance & Economics, HangZhou 310012, China
2 College of Business management, ZheJiang University of Finance & Economics, HangZhou 310012, China

Abstract: - GML is best thought of as a Language for geographical data description. but it doesn’t provide any information about how the map data should be displayed. Numerous mapping solutions are provided from different angels. This paper analyses and compares kind of products and technologies about GML data displaying, and find that there are mainly three basic strategies to be used in the majority of cases. We attempt to compare and contrast the three strategy of GML data visualization with the application model, further analyze the SVG technology in details, the comparatively satisfying strategy, present its advantage and provide a simple applicant structure.

Key-Words: - GML, WebGIS, SVG, raster graphic, Vector graphical formats

1. GML Introduction

Nowadays, the internet is the main platform for data sharing. The development of internet has demanded that our technologies have to be extensible and comprehensible. Thus to share and integrate geographic data in the internet environment requires a standard data format which is interoperable, extensible and suitable for internet technology.

GML is developed as an implementation specification by the Open Geospatial Consortium to data interoperability and exchange between different systems. It is more than an exchange format. It is modeling language with a rich set of primitive objects (geometry, topology, times, coverage, units of measure…) and a basic modeling framework for constructing application objects from these primitives. [1]

The GML is an XML-based language to represent geographical data and their meaning. The geographical data refer to a spatial representation of the world, independent of any specific visualization of the data. The GML has its own structure to code spatial data and their associations: this structure can be extended also to modeling a specific application context. In general, the GML has the capacity to combine and to associate spatial data with other types of data (XML or GML expressed), leading to a solution the problem connected to the integration with heterogeneous data. [2]

Unlike current proprietary commercial Internet GIS programs, the OpenGIS GML specifications are the public open standard for coding and sharing spatial data. GML is a good alternative to expensive, proprietary web-based mapping solution.

2. Visualization Strategy Comparison

GML upholds the principle of separating content from presentation, so it does not address the visualization of encoded data. In other words, GML contains map “content” only (e.g. where feature are, their geometry, type and attributes), but it doesn’t provide any information about how the map data should be displayed[3][4]. However, the importance of visualizing the content remains unchange.
geographic data visualization graphical visual properties such as colors and symbols play an important role to make the presentation more informative and effective.

Up to now, numerous solutions are provided from different angles, but there is not a perfect strategy to visual geographic data methods. We analyze and compare kind of products and techniques about GML data displaying, and find that there are mainly three basic strategies to be used in the majority of cases, namely: raster-based visualization strategy, controls-based visualization strategy, vector graphical formats-based visualization strategy.

2.1 Raster-based Visualization Strategy

Raster graphic such as GIF(Graphics Interchange Format), JPEG(Joint Photographic Experts Group) and PNG(Portable Network Graphics) are displayed by a method of filling in a matrix of pixels, which requires storing the information for every pixel of graphic.

In this case, Client user asks the Webserver for the graphic of GML, and web server accepts the request, calls the GML map server to process request coming from browser. GML map server transfers GML data to raster graphic which is delivered to web server. Web server delivers static HTML pages in which the raster graphic is nested to web browser. The architecture of raster-based visualization strategy is shown in Figure 1.

![Figure 1 Architecture of Raster-based Visualization strategy](image)

The advantages as following: client-side is relative simple, no special rendering plus-ins are required. The disadvantages as following: network transmissions are overburdened; server system performance doesn’t work well; there are short of map layer control functions; raster graphics are viewed on different kinds of screens and in different sizes; When an image is scaled, anti-aliasing comes into play, the lines become jagged and the image blurred or “pixilated” due to the pixel data being smeared.

2.2 Controls-based Visualization Strategy

Controls means component or plus-ins which can be downloaded and executed by a web browser, which can be implemented some additional functions of user questions through similar-programming language such as Java applet, Active X, plug-ins.

In this case, Web server do not have to response all user question, but to render the GML data file and controls which are used to control GML data to web browser. Then controls generates a Dynamic HTML (DHTML). Therefore, user can construct multi-layer map presentations geographic data which are represented as GML files by mean of these module. Once a map layer is rendered for the first time by the client, it is cached by the browser, and subsequent operations on this layer, such as zooming, roaming, do not cause additional server round-trips. The architecture of controls-based visualization strategy is shown in Figure 2.

![Figure 2 Architecture of Controls-based Visualization strategy](image)
network transmissions is relatively high; it offers dynamic interactivity that can respond to user actions. The disadvantages are obvious: different controls unit are developed according with different web browsers; developing methods are opaque and not open.

2.3 Vector graphical formats–based Visualization Strategy

A main goal of GML is to represent the content of geographical data. This language can be used also to represent these data as maps, by using a rendering tool to interpret the GML data. In other words, it is necessary to "re-code" the GML elements in a suitable way so that they can be represented, for example, by the graphical display of a web browser (map styling). This operation interprets the GML contents by means graphical symbols, line styles, areas filling, sometime also the transformation of the data geometry according to the representation requested.

Generally this process (graphical rendering) transforms the GML data in a XML graphical format. Some major vector graphical formats for viewing is: Scalable Vector Graphics (SVG); Microsoft’s Vector Markup Language (VML); Web 3D by X3D Consortium; the XML incarnation of the syntax and behaviour of VRML (Virtual Reality Markup Language).

These specifications are in many ways similar to GML, but have a very different objective. Each has a means of describing geometry. The graphical specifications, however, are focused on appearance and hence include properties and elements for colors, line weights and transparency to name a few aspects.

In this case, the different place with first two kind of strategies are that GML map server extract information data from GML data file and transform them into one of the graphical vector data formats such as SVG, VML or VRML. As long as web browser supports vector graphics, the map can be displayed without any additional software. Today a variety of graphical render programs are available for the various XML graphical formats, both as native in the web browser, as plug-in for the browser, as stand-alone viewer, or as library of functions. In the case of VML this is built into IE5.0 (and nowhere else). In the case of SVG, Adobe is developing a series of plug-ins for Internet Explorer and Netscape Communicator. The architecture of vector graphical formats based visualization strategy is shown in Figure 3.

![Figure 3 Architecture of Vector graphical formats-based Visualization strategy](image)

In this case, the most important aspect in our view is its transformability. It is quite easy to write a transformation which carries GML data to graphical formats based on XML. Such transformations can be accomplished using a variety of mechanisms including XSLT, JAVA, JAVASCRIPT and C++ to name only a few. XSLT is of particular interest. With XSLT it is very easy to write a style sheet which locates and transforms GML element into other XML elements. Where XSLT is not up to the task, one can readily incorporate XSLT extension functions tasks such as string manipulation or mathematical computation. XSLT can also make use of powerful searching syntax (XPath/XQL) so as to retrieve elements that satisfy complex Boolean expressions on the elements and their attributes. Using these techniques an XSLT style sheet can perform a wide variety of querying, analysis and transformation functions [3]. So we can generate a SVG, VML or X3D map on the server, select different style sheets for different
viewing devices or different types of maps.

3. The Better Application Model

-SVG&GML

From the above comparative analysis, and the current application status, we believe that the SVG technology is a better choice for GML data visualization...

3.1 SVG overview

SVG, an abbreviation for Scalable Vector Graphics, is defined as a language for describing two dimensional graphics and graphical applications in XML. It is an open standard developed and supported by the World Wide Web consortium.

SVG allows for three main types of graphic objects; vector graphic shape (e.g. paths consisting of straight lines and curves), images and text. In addition it also supports gradient fills, filters and reusable components such as symbols and markers. In SVG graphical objects can be grouped; styled, transformed and composites into objects. Furthermore, the feature set may include nested transformations, clipping paths, alpha masks, filter effects, template objects and both procedural and declarative animation.[5]

3.2 SVG Advandage

Here are some of the most important advantage SVG gives us compared to other formats:

- Open standard: SVG is an open recommendation developed by a W3C and unlike some other graphics formats, SVG is not proprietary[6].
- Widespread and enthusiastic support: SVG has been widespread, enthusiastic support by web industry leaders and developers. Specialy, IBM, Netscape & Microsoft have declared, or, have already developed, SVG Views or supporting graphics libraries.
- True XML based: Since SVG is an XML grammar, it offers all the advantages of XML such as Interoperability, Internationalization (Unicode support), and Easy transformation through XML Stylesheet Language Transformation (XSLT).
- Custom map styling: Different “style sheets” can be applied to the geographic data to make it appear however the user wishes.
- Editable: Once GML has been converted to SVG, the user can apply graphic editing tools on the client to add text (of any font, size and color), highlight features, and draw virtually any kind of shape on the map.
- Zoomable: You can zoom and pan an SVG diagram without degradation of image[6].
- Interactivity and intelligence: Since SVG is XML-based; it offers dynamic interactivity that can respond to user actions. In addition to the built-in events and event handlers that allow interactivity you can still add additional types of interactivity by using JavaScript to manipulate the Document Object Model (DOM) of the SVG document of image [6].

3.3 Application Structure of the model

From the above section, we can give the simple application structure of using the SVG &GML model as following figure 4.
Figure 4 simple application structure of using the SVG &GML model

Web server contains two main servers, Web Feature Server and Web Map Server. The Web Feature Server is in charge of providing a well-known structure and mechanism for query and retrieval of geographic features. While The Web Map Server is in charge of providing an excellent mechanism for quickly developing applications that allow a client to display a map.

Web browser want to get some maps, so it makes a request and posted to the web feature server, the web feature server access to the GML data and process the request and send back the geographic features defined as GML document.

An XSLT processor reads the GML features document and compresses the elements it finds there to the patterns in the style sheet. When a pattern from the XSLT stylesheet is recognized in the input GML features document, the XSLT processor outputs the result SVG file.

4. Conclusion

GML data visualization technology is in developing and thriving phase. Various kinds of technologies participate in the domain in succession and numerous solutions are provided from different angels. This writer generalize from various technologies are concerned with XML visualization, and sum up to three kind of GML visualization strategy used in the majority of cases. Further, this paper compares and analyst their architecture and respective characteristic.

Through a series of comparison, we see that the SVG technology is a relatively excellent one on GML data visualization. At the same time, we present its advantage and its application structure.

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